APPENDIX C

Climate Change Resiliency and Adaptation in a Comprehensive Context

Climate change, which refers to long-term changes in average weather conditions, has led to a global temperature increase of approximately 2 degrees Fahrenheit over the past century. It presents a range of challenges and opportunities for farmers. As the climate continues to change, farmers must adapt their practices to address these impacts and ensure their operations' long-term sustainability and productivity. The rising average temperatures and more frequent extreme heat events stress crops and livestock, reducing yields and increasing susceptibility to pests and diseases. Warmer temperatures also alter the growing season, potentially affecting crop phenology, resulting in earlier maturation and necessitating planting and harvest date adjustments.

Climate change is also expected to increase the frequency and severity of extreme weather events, such as storms, flooding, and droughts, which can damage crops, erode soils, and disrupt agricultural operations.

Despite being indirectly affected by rising sea levels, Yates County faces the consequences of climate change, including higher temperatures, more frequent heatwaves, increased intensity and frequency of heavy rainfall events, and more severe and long-lasting droughts.

To successfully navigate these challenges, Yates County farmers will need to adopt innovative and adaptive strategies that increase the resilience of their agricultural systems, such as climate-smart agriculture practices, diversification of crop varieties, and improved water and pest management techniques. By engaging in proactive planning and implementing sustainable practices, the region can better prepare for and adapt to the impacts of climate change.

Impacts on Agriculture

The agricultural sector in Yates County is expected to face both challenges and opportunities as a result of climate change. The growing season has extended by an average of 8 days, significantly increasing summer heat stress days. The warmer climate presents various heat stress challenges, such as reduced crop yields, negative effects on carbohydrate accumulation, sunscald damage on cool season-adapted crops, and increased vulnerability to frost damage due to accelerated leaf and bud development.

However, the longer growing season also offers unique opportunities for farmers, such as experimenting with new, warm climate-favored crops and mitigating some heat stress by adjusting planting dates.

Farmers can adopt a variety of climate change strategies to increase the resilience of their agricultural operations and reduce their environmental impact.

Livestock Production

Increased temperatures are anticipated to affect dairy production as heat stress becomes more prevalent adversely. Dairy farmers can mitigate these impacts by ensuring adequate water supply, preventing overcrowding, and adjusting rations to include higher quality forages instead of increasing grain.

Precipitation Impacts

Another critical impact is the shift in precipitation patterns, including more intense rainfall events, increased periods of drought, and changes in the timing of seasonal precipitation. These shifts can lead to increased soil erosion, nutrient runoff, and water management challenges, such as dealing with water scarcity or excess water, which can harm crops and infrastructure. As climate change progresses, intense precipitation events are predicted to become 50-100% more frequent, and droughts are expected to increase in frequency and severity. These changing precipitation patterns can cause insufficient water supply for animals and crop losses, with drought conditions being exacerbated by heatwaves.

In 2016, Cornell University conducted a survey of farmers following a record-breaking drought. The survey, funded by Cornell University's Atkinson Center for a Sustainable Future and The Nature Conservancy, sought to understand how organizations such as Cornell Cooperative Extension, university researchers, and government or non-government agencies could help farmers cope with future drought risks. Farmers expressed interest in learning more about drought-resistant crop varieties, irrigation development and planning, improving soil quality and water retention, water-saving ideas, pasture rotation, silvopasture, rotational grazing, stockpiling forage, minimizing the effect of drought, and identifying pests and diseases that are more or less prevalent during droughts. Additionally, farmers emphasized the importance of addressing mental stress related to drought and climate issues.

In response to the same question, farmers highlighted the need for more resources and support, including the development of online tools and better long-range forecasting, on-farm courses and training, and educational materials about agriculture and drought. They also requested financial assistance to cover drought losses, inventory of vacant farmlands for potential use, financial aid for irrigation equipment and ponds, and support for soil improvement and water management initiatives.

Moreover, they called for crop-specific crop insurance or discontinuation of insurance that encourages growing ill-suited crops, rentable and leasable irrigation equipment, cheaper county water for agricultural use, and cost-sharing for cover crops, no-till supplies, and multi-purpose ponds. These insights highlight the diverse needs of farmers as they face increasing climate-related challenges and underscore the importance of tailored support and resources to help them adapt and thrive.

Pests and Disease Risks

These climate change impacts also have implications for pest and disease management, as changing temperatures and precipitation patterns can create more favorable conditions for the spread of invasive alien species (IAS), pests, and diseases that negatively affect crops and livestock. For instance, the brown marmorated stink bug has caused substantial damage in New York State.

The stink bug is an invasive insect species native to East Asia, particularly China, Japan, and Korea. It was first discovered in the United States in the late 1990s in Pennsylvania and has since spread to many other states, causing significant agricultural and nuisance problems.

It feeds on a wide variety of crops, including fruits, vegetables, and ornamental plants, causing significant damage and economic losses. Some of the crops most affected by this pest include apples, peaches, pears, cherries, grapes, corn, soybeans, and peppers. The stink bug pierces the surface of the fruit or plant tissue with its needle-like mouthparts to feed, leading to discoloration, deformities, and reduced crop yields.

Pest management can be challenging as some IAS are resistant to traditional pesticides, and harsher control methods may inadvertently harm essential insects such as pollinators. Furthermore, some pests may develop resistance to pesticides, necessitating the use of increasingly potent chemicals to eradicate populations.

To help farmers adapt to climate change, various programs, such as the Cornell Climate Smart Farming Program and the Climate Resilient Farming Program, provide resources, guidance, and funding opportunities for implementing best management practices, enhancing on-farm adaptation, upgrading infrastructure, increasing energy efficiency, and adopting climate-smart agricultural practices.

NYS Climate Action Council Scoping Plan (2022)

In 2019, New York State passed the Climate Leadership and Community Protection Act (Climate Act) to reduce 85% of NYS's greenhouse gas (GHG) emissions by 2050. As part of the act, it called upon a 22-member Climate Action Council to develop a Scoping Plan outlining how NYS will reach its climate goals. The Scoping Plan provides recommendations for each significant GHG emitting sector, outlining how to achieve the Climate Act's goals and requirements. This plan identifies six major sectors, including Agriculture and Forestry. **Below will be a summary of the recommendations for the Agricultural Sector and how Yates County can help meet the Act's goals and requirements.**

GHG emissions from the Agricultural Sector include methane, nitrous oxide, and carbon dioxide. Overall, agricultural emissions represent 6% of statewide emissions, with 92% from livestock and 8% from soil management practices. Although agriculture and forestry practices contribute significantly to GHG emissions, they also provide several climate change mitigation ecosystem services. For instance, the carbon sequestration of forested lands and long-term storage in harvested wood products make up 97% of all GHG emission removal in the State. To reduce Agricultural Sector GHG emissions, the NYS Climate Action Council developed several agricultural and forestry-focused strategies to be implemented to sequester 60 MMT of CO_2.

Advance Alternative Manure Management

One-third of all agricultural methane emissions in NYS come from manure management. Significant methane emissions come from improperly storing methane, leading to anaerobic decomposition. In addition to exclusive methane emission, improper manure storage can lead to manure getting caught in stormwater runoff and thus polluting nearby waterways. Implementing effective manure management can mitigate pollution it causes and reduce farmer dependency on syntenic fertilizers. To improve manure management, this scoping plan provided several strategies that can be implemented now and recommendations for the future.

- Expand the Climate Resilient Farming program to assist farmers in implementing alternative manure management practices.
- Establishes government partnerships with the private sector and NGOs involved in the methane reduction industry
- Expand the capacity of the Soil Water and Conservation District (SWCD) Office's capacity to aid on-farm manure management implementation
- Expand NYSERDA funding to implement on-farm methane energy production systems
- Connect farmers with businesses that work in organic waste management or methane energy production

Advance Precision Feed and Forage

The methane emission from feed digestion by livestock represents the largest source of agricultural GHG emissions. However, any actions to reduce these emissions must be compatible with farmers' goals to grow their livestock and dairy cow lactation goals, not to harm their revenue. Therefore, to improve livestock feed management, this scoping plan provided several strategies that can be implemented now and recommendations for the future.

- Expand educational opportunities for farmers to learn about precision feed practices and access precision feed monitoring tools
- Expand the capacity of SWCDs to assist farms with implementing precision feed practices
- Establish co-product markets to collect food wastes from processors and retailers to be used as livestock feed
- Expand funding for research into methane-mitigating feed additives

Herd Management

One of the effective ways to mitigate greenhouse gas emissions in agriculture, particularly in livestock farming, involves expanding educational opportunities and promoting professional conservation and herd management practices. These practices aim to neutralize methane emissions from livestock and boost carbon sequestration.

Among the practices that can be encouraged is silvopasturing. This practice integrates trees, pasture, and livestock in the same land management system. The trees help sequester carbon while also providing shade and wind protection for animals. In turn, the animals help fertilize the trees and reduce the need for mechanical maintenance.

Rotational grazing is another crucial practice that could be included in these plans. By regularly moving livestock to fresh pastures, farmers can prevent overgrazing and allow previously grazed land to recover, enhancing soil health and promoting carbon storage.

The promotion of grass-fed livestock can also play a significant role in mitigating methane emissions. Grass-fed animals typically have a lower environmental impact than those fed on grain, and the pastures on which they graze can serve as significant carbon sinks.

Selective breeding practices for maximum nutritional efficiencies and early maturation, often referred to as the 'easy-keeper theory', can also contribute to reducing methane emissions. By

selectively breeding animals that mature early or utilize feed more efficiently, farmers can decrease the overall methane emissions per unit of livestock product.

The use of working forest buffers and grasses for carbon sequestration is another important strategy. These plantings not only sequester carbon but also provide habitat for wildlife, increase biodiversity, and can reduce soil and nutrient runoff into nearby waterways.

Another innovative approach is combining solar energy generation with grazing, as shown in a study by Cornell University. Known as agrivoltaics, this practice involves installing solar panels over grazing lands, providing shade for animals and pasture while generating renewable energy. The study found that this approach can improve land efficiency, protect livestock from harsh weather, and increase the productivity of pastures.


Made in the shade: Growing crops at solar farms yields efficiency

By Blaine Friedlander, Cornell Chronicle

March 1, 2023

Figure 1: Article Title on Agrivoltaics

By educating farmers about these practices and offering professional guidance and support, it is possible to transform the agricultural landscape into one that is sustainable, efficient, and beneficial for both the economy and the environment.

Advanced Agricultural Nutrient Management

Only 9% of all agricultural emissions are N_2O, mostly from crop nutrients and soil amendment applications. Maintaining the health of agricultural soil is important not only for the productivity of crop growth but also because agricultural soil provides many ecosystem services. These services include sustaining biological diversity and improving water quality through pollutant filtration, nutrient cycling, carbon sequestration, and runoff mitigation. While farmers have significantly reduced the amount of N_2O emission over the last several decades, more work can be done to further reduce emissions by focusing on the rate, sources, placement, and timing of nutrient applications. To improve nutrient management, this scoping plan provided several strategies that can be implemented now and recommendations for the future.

- Increase funding through CRF and Agricultural Nonpoint Source Abetment and Control (AgNPS) programs to implement better nutrient management through farm-specific AEM plans
- Expand cost-sharing for equipment needed to improve nutrient management practices in unrepresented farming areas.
- Enhance workforce training and SWCDS capacity to help implement nutrient management practices

Adopt Soil Health Practice Systems

As mentioned, agricultural soils provide numerous ecosystem services, which can help reduce GHG emissions such as carbon sequestration. Additionally, improving soil health can have the additive benefit of reducing the need for nitrogen-based fertilizers. Several soil management best practices

include cover cropping, conservation crop rotations, and prescribed grazing. To improve soil management and increase the use of these best practices, this scoping plan provided several strategies that can be implemented now and recommendations for the future.

- Expand current funding opportunities such as CRF, AEM, and AgNPS to encourage the adoption of soil management best practices
- Increase the adoption of soil management best practices on rented/leased lands
- Support the conversion of annual croplands to perennial hay/pastureland or forests where appropriate (Steep slopes or erodible land)
- Develop tools to quantify the environmental benefits of adopting soil management best practices
- Improve networking opportunities between farms to share best practices
- Conduct municipal-wide farm planning to identify best practices and locations for improving carbon sequestration goals

Increase Adoption of Agroforestry

Adding trees to farm areas can significantly increase the carbon sequestration rate and provide ecosystem services that benefit agricultural production. To improve agroforestry adoption, this scoping plan provided several strategies that can be implemented now and recommendations for the future.

- Expand CRF programs that incentivize agroforestry and set acreage targets
- Expand programs that incentivize silvopasturing, alley cropping, and developing riparian buffers
- Support long-term leasing and farm transfers for long-term perennial systems

Develop Agricultural Environmental Management Planning for Climate Adaptation and Mitigation

Agricultural and environmental management (AEM) planning is a program overseen by NYS agencies but is implemented on farms through collaboration with the farmer and the County SWCD. Recent directives from the State insist that new AEMs for farms should have a considerable focus on "carbon farming," which means developing strategies to reduce GHG emissions and increase carbon sequestration rates. To meet the State's goals of improving carbon farming, this scoping plan provided several strategies that can be implemented now and recommendations for the future.

- Develop protocols for carbon farming that align state and federal programs to optimize grant opportunities and develop protocols to establish statewide consensus
- Conduct outreach to farmers to educate them on the environmental benefits of carbon farming and the personal benefits for them

Monitor and Benchmark Agricultural Greenhouse Gas Emissions

Monitoring and benchmarking GHG emissions and carbon capture practices will be critical in determining the success of the intended goals for this scoping plan. Therefore, to establish effective

strategies for measuring the effectiveness of GHG emission-reducing strategies and carbon capture techniques, this scoping plan provided several strategies that can be implemented now and recommendations for the future.

- Have state agencies such as the AGM and DEC establish funding for monitoring and benchmarking programs
- Develop methods to benchmark success at the farm, county, and state levels, as well as make the data publicly accessible
- Conduct outreach to educate and encourage farmers to participate in monitoring and benchmarking programs

Establish a Payment for Ecosystem Services Program

There is yet to be a pathway for farmers to receive direct financial benefits for generating ecosystem services on their farms. As a result, best management practices that improve the rates of ecosystem service production can be costly to implement. This leads to a decreased incentive for farmers to start implementing these practices. However, paying farmers for these services will have a two-fold effect. Firstly, it will lead to an increased rate of ecosystem service being produced. Secondly, it will provide a much-needed source of revenue that ensures these farms stay in operation, producing food and ecosystem services. To ensure the increased production of ecosystem services, this scoping plan provided several strategies that can be implemented now and recommendations for the future.

- Have the AGM and DEC develop and design a funding program for ecosystem service payments that focuses on carbon sequestration, improved water quality, and flood resilience
- Establish outreach programs to educate farmers on ecosystem services and attract them to the reprogram

Bolster Local Agricultural Economies

Bolstering the State's agricultural economy will support the reduction of GHG emissions by decreasing the transportation required to bring food from around the county and the world to support food needs in NYS. Additionally, this will increase local marketing opportunities, thus making farmers more financially stable. Strategies to increase the State's agricultural economy will focus on enhancing and expanding current programs already in place.

- Expand current programs such as the farmers market nutrition program and farm-to-school programs that support the procurement of NYS agricultural products
- Expand outreach programs to farms that help with business planning
- Support the expansion of the local supply chain to increase production capabilities for new agricultural products